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THE CHRONOLOGY

AND

ORDER OF OSSIFICATION OF THE BONES

OF THE

UNIVERSITY OF ILLINOIS
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HUMAN CARPUS

X-RAY METHOD

UNIVERSITY OF ILLINOIS LIBRARY

BY

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Lexington, Ky.
Press of Trannsylvania Company,
1908

FRONTISPIECE—W. T., Male, Age 11 Years, 3 Months, 3 Days.

The Chronology and Order of Ossification of the Bones of the Human Carpus.

In the abstract of an article on the "Hereditary Nature of Variations in Ossification of Bones,"[1] read at the meeting of the Association of American Anatomists, at Madison, Wis., March 28th, 1907, and published in the Anatomical Record of the American Journal of Anatomy, the following observations on the ossification of the bones of the human carpus were noted:

First.—The process of ossification is inaugurated much sooner than hitherto supposed.

Second.—The bones of the female ossify in advance of the male. This is measured at first by days, then months, then years.

Third.—The chronological order in which the bones of the carpus are ossified is different from that formerly supposed.

Fourth.—The bones of the first child, as a rule, ossify sooner than those of subsequent children of the same parents.

Fifth.—Regardless of the variations (normal) the ossification is bilaterally symmetrical.

Sixth.—The union of the epiphyses with the shaft takes place much sooner than formerly supposed.

Seventh.—Variation in the ossification of bones is a heritable trait.

Previous to the reading of this paper, two publications were issued from the Laboratory of Anatomy and Physiology of the State College of Kentucky, pertaining to this subject.[2]

In the first article published, under the title of "The Development of the Bones of the Hand as shown by the X-Ray Method," the following summary was given:

1. American Journal of Anatomy, Vol. VI, 1907.
2. Bulletin Series 2 No. 5.
   Bulletin Series 3 No. 4.

Fig. I.—N. W., Female, 6 Years, 2 Months, 15 Days.

Fig. II.—P. M., Male, 8 Months, 25 Days.

Fig. III.—P. M., Male, 1 Year, 6 Months, 6 Days.

Fig. IV.—W. S., Male, 1 Year, 9 Months, 10 Days.

SUMMARY.

CARPUS

- **Os magnum**
  - *Female:* between the third and fourth months.
  - *Male:* between the seventh and eighth month.
- **Unciform**
  - *Female:* between the third and ourth month.
  - *Male:* between the seventh and eighth month.
- **Cuneiform**
  - *Female:* thirteenth or fourteenth month.
  - *Male:* early in the third year.
- **Semilunar**
  - *Female:* late in third or early in fourth year.
  - *Male:* between fourth and fifth year.
- **Scaphoid**
  - *Female:* when about four years of age.
  - *Male:* when about six years of age.
- **Trapezoid**
  - *Female:* between the fourth and fifth year.
  - *Male:* between the fifth and sixth year.
- **Trapezium**
  - *Female:* between the fourth and fifth year (usually preceded by trapezoid).
  - *Male:* early in the eighth year (usually preceded by trapezoid).
- **Pisiform**
  - *Female:* between the ninth and tenth year.
  - *Male:* between the twelfth and thirteenth year.

As stated at that time, "The conclusions are in a sense tentative and the summary incomplete." A large number of cases would have to be studied before the average could be positively determined.

At the present time I have observed five hundred and fifty-four (554) hands,

Fig. V.—H. C. T., Male, 6 Years, 4 Months, 25 Days.

Fig. VI.—L. F., Female, 5 Years, 9 Months, 28 Days.

Fig. VII.—E. T. R., Male, 5 Years, 10 Months, 3 Days.

Fig. VIII.—M. R., Female, 5 Years, 1 Month, 9 Days.

of which two hundred and sixty-six (266) were of the female and two hundred and eighty-eight (288) were male.

Of this number one hundred (100) of the females were under seven years of age. Of the males one hundred and six (106) were under seven years of age.

A careful study of these hands confirms the observations made, but some changes must be made in the summary as presented in the first publication.

The first observation, viz., "The process of ossification is inaugurated much sooner than hitherto supposed," and the third: "The chronological order in which the bones of the carpus are ossified," will be considered in this article.

In the table herewith given I have included only those in which the chronology was distinct. There is, of course, opportunity for error in this. There may possibly be a much larger proportion of cases in which the unciform has preceded the magnum than is indicated by their relative size. There could not be great error in this, at least not enough to materially change the result or influence the conclusions. I have not tried to obtain a large number of subjects under one year of age for the reason that the results were uniform in such a large majority that it seemed unnecessary. The magnum is a larger bone than the unciform and the nucleus of the former will soon exceed in size the latter. This would indicate that the rate of deposit of lime salts in the larger bone would exceed that of the smaller bone. However, the larger size of the nucleus does not always indicate priority of appearance.

The deposit of lime salts in anticipation of the shape of the completed bone is fairly uniform in all instances, and is peculiar to each bone.

In all of the bones of the carpus the first appearance is that of a pin point. This will become round and then elongate, and as it enlarges the shadow will be characteristic of each bone. Thus that of the magnum will be longer in the vertical diameter and is usually constricted in the middle. The unciform always assumes a triangular shape, with the apex toward the centre and directed obliquely downward and inward. The cuneiform becomes oval with the long diameter obliquely downward and inward.

The semilunar remains round on the surface, but often becomes pyramidal. The scaphoid rapidly grows in the long diameter of the bone and soon distinctly anticipates the boat shape. The trapezoid and trapezium remain round until they are quite large. Although the palmar surface of the bone is in contact with the plate, the shadow cast is largely determined by the dorsal surface which is interposed between the tube and the plate, thus obstructing the rays. When the negative is compared with the bone, the resemblance to the dorsal surface is distinct.

Fig. IX.—C. B., Female, 5 Years, 9 Months, 17 Days, right.

Fig. X.—C. B., Female, 5 Years, 9 Months, 17 Days, left.

Fig. XI.—S. G., Female, 5 Years, 1 Day, right.

Fig. XII.—S. G., Female, 5 years, 1 Day, left.

CHRONOLOGICAL TABLE.

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
1. A. C. K...	F.	3- 8	2nd	0	1	0	0	0	0	0	0	U. .1
2. E. C.	F.	6	2nd	1	2	0	0	0	0	0	0	M. 5-U. 4
3. P. D. D...	F.	8- 5	4th	1	2	0	0	0	0	0	0	M. 5-U. 3
4. M. B.	F.	1- 2-20	1st	1	2	3	0	0	0	0	0	M. 7-U. 6-C. 1.7
5. A. C. K...	F.	1- 5- 1	2nd	2	1	0	0	0	0	0	0	M. 4-U. 5
6. C. G. B...	F.	1- 9-24	1st	1	2	0	0	0	0	0	0	M. 9-U. 7
7. C. D.	F.	2- 2-23	4th	1	2	3	0	0	0	0	0	M. 8-U. 7-C. 5
8. M. B.	F.	2- 3-10	1st	1	2	3	0	0	0	0	0	M. 9.U. 8-C. 4
9. E. C.	F.	2- 5-13	2nd	1	2	3	4	0	0	0	0	C. 3-S. 2
10. R. N.	F.	2-10-12	2nd	1	2	0	0	0	0	0	0	M. 10-U. 8
11. M. B.	F.	3- 2- 9	1st	1	2	3	4	0	0	0	0	S. 2
12. E. W. ...	F.	3- 6-21	2nd	1	2	3	4	6	0	5	0	M. 13-Sc. 2.5-U. 10-C. 7-S. 4-Tm. 3
13. J. B. S....	F.	3- 7-25	2nd	1	2	3	0	0	0	0	0	C. 4
14. C. R.	F.	3- 7-26	2nd	1	2	3	4	0	5	0	0	C. 6-S. 5-Td. 2
15. N. S.	F.	3- 8-28	1st	1	2	3	0	0	0	0	0	C. 4
16. C. S.	F.	3-10-14	2nd	1	2	3	4	0	0	0	0	C. 5-S. 2
17. R. A.	F.	3-10-20	2nd	1	2	3	0	0	0	0	0	C. 6
18. M. M.	F.	3-11- 4	3rd	1	2	3	0	0	0	0	0	C. 2
19. J. M.	F.	3-11-22	11th	1	2	3	4	0	0	0	0	C. 4-S. 3
20. B. D.	F.	4- 0- 0	6th	1	2	3	4	0	0	0	0	C. 6-S. .3
21. A. P.	F.	4- 0- 0	4th	1	2	3	4	0	6	5	0	C. 6-S. 5-Td. 3-Tm. 1.
22. C. F.	F.	4- 1- 7	1st	1	2	3	4	5	7	6	0	S. 7-Sc. 6-Td. 4 Tm. 5
23. E. H.	F.	4- 1-23	4th	1	2	3	0	0	0	0	0	C. 5
24. M. B.	F.	4- 2-18	2nd	1	2	3	4	0	0	0	0	C. 5-S. 3
25. D. P.	F.	4- 4-24	7th	1	2	3	4	6	5	7	0	S. 7-Sc. 2.5-Td. 3-Tm. 2
26. I. S.	F.	4- 6- 0	2nd	1	2	3	4	0	0	0	0	C. 6-S. 5
27. M. L. K..	F.	4- 7- 9	1st	2	1	3	4	5	0	0	0	S. 4-Sc. .8
28. B. D.	F.	4- 8-18	3rd	1	2	3	4	6	5	0	0	S. 5-Sc. 4- Td. 3.5
29. J. L. W..	F.	4- 9- 5	...	1	2	3	4	5	0	0	0	S. 5-Sc. 1.2
30. E. J.	F.	4- 9-12	...	1	2	3	4	5	6	7	0	S. 6
31. V. A.	F.	4-10-15	1st	1	2	3	4	5	0	0	0	Sc. .8
32. E. B.	F.	4-10-22	1st	1	2	3	4	7	6	5	0	S. 8-Sc. 5-Td. 4-Tm. 7
33. R. H.	F.	4-11- 7	3rd	1	2	3	4	7	5	6	0	S. 5-Sc. 1-Td. 3.2-Tm. 2
34. S. G.	F.	5- 0- 1	2nd	1	2	3	7	5	6	4	0	S. 2-Sc. 3-Td. 2.5-Tm. 5
35. M. R.	F.	5- 1- 9	1st	1	2	3	7	6	4	5	0	S. 3-Sc. 4.8-Td. 5.2-Tm. 1
36. J. M. F...	F.	5- 1-12	6th	1	2	3	4	0	6	5	0	S. 5-Td. 4-Tm. 5
37. R. E.	F.	5- 1-12	3rd	1	2	3	4	0	5	6	0	S. 6-Td. 3.2-Tm. 3

Fig. XIII.—L. F., Male, 5 Years, 4 Months, 9 Days, right.

Fig. XIV.—L. F., Male, 5 Years, 4 Months, 9 Days, left.

Fig. XV.—J. P. Male, 6 years, 3 Months.

Fig. XVI.—I. B., Female, 6 years.

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
38. E. K.	F.	5- 1-12	1st	1	2	3	4	7	6	5	0	S. 6-Sc. 2-Td. 3-Tm. 4
40. I. R.	F.	5- 1-16	4th	1	2	3	4	0	5	0	0	S. 4-Td. .2
41. A. M. W.	F.	5- 1-21	4th	1	2	3	4	0	0	0	0	S. 2.5 .
42. L. F.	F.	5- 3-13	1st	1	2	4	3	6	5	0	0	C. 5-S. 8-Sc. 1-Td. 2
43. T. C.	F.	5- 3-22	3rd	1	2	3	4	0	0	0	0	S. 5
44. H. S.	F.	5- 3-27	2nd	1	2	3	0	0	0	0	0	C. 3
45. C. S.	F.	5- 4- 7	1st	1	2	3	4	0	5	6	0	S. 5-Td. 2-Tm. .2
46. C. B.	F.	5- 9-17	3rd	1	2	3	0	5	4	0	0	Sc. 5-Td. 6
47. E. J.	F.	5- 5-12	1st	1	2	3	7	5	6	4	0	Sc. 4.6-Td. 4-Tm. 5
48. A. W.	F.	5- 5-22	3rd	1	2	3	5	4	6	0	0	S. 3-Sc. 4-Td. 1
49. A. P.....	F.	5- 6- 1	4th	1	2	3	4	7	6	5	0	S. 7-Sc 3-Td. 5 Tm. 6
50. M. P.	F.	5- 6-24	4th	1	2	3	0	0	0	4	0	M. 3
51. M. E.	F.	5- 7- 0	1st	1	2	3	5	6	7	4	0	S. 6-Sc. 8-Td. 5 Tm. 8.2
52. M. V.	F.	5- 7- 3	1st	1	2	3	4	6	5	7	0	Sc. 5-Td. 6-Tm. 4
53. M. S.	F.	5- 7- 8	2nd	1	2	3	4	0	5	6	0	Td. 3-Tm. 2
54. A. L. F...	F.	5- 7-20	10th	1	2	3	4	0	0	0	0	S. 5
55. V. B.	F.	5- 7-24	1st	1	2	3	4	6	5	7	0	Sc. 5-Td. 6-Tm. 3.5
56. V. Y.	F.	5- 7-29	4th	1	2	3	7	5	6	4	0	S. 4-Sc. 6-Td. 51Tm. 9
57. M. R.	F.	5- 8- 5	1st	1	2	3	4	6	7	5	0	Sc. 5-Td. 6-Tm. 7
58. E. C.	F.	5- 9-14	2nd	1	2	3	4	7	5	6	0	Sc. 2.5-Td. 5-Tm. 4
59. L. F.	F.	5- 9-28	1st	1	2	4	3	6	5	0	0	Sc. 6-Td. 5
60. H. S.	F.	5-10- 9	3rd	1	2	3	4	5	6	7	0	Sc. 4.1-Td. 4-Tm. 3
61. R. K.	F.	5-10- 9	3rd	1	2	3	6	7	4	5	0	S. 3.5-Sc. 2.5-Td. 5-Tm. 4
62. V. C.	F.	5-10-14	2nd	1	2	3	4	7	5	6	0	Sc. 4-Td. 6-Tm. 5
63. H. P. R...	F.	5-11-16	1st	1	2	3	4	7	5	6	0	Sc. .3-Td. 3-Tm. 2
64. A. W.	F.	5-11-28	3rd	1	2	3	0	0	0	0	0	
65. I. B.	F.	6- 0- 0	1st	1	2	3	5	0	4	0	0	
66. M. B.	F.	6- 0- 2	...	1	2	3	0	0	0	0	0	
67. B. F.	F.	6- 0- 3	1st	1	2	3	4	5	6	7	0	
68. H. T.	F.	6- 0- 4	3rd	1	2	3	4	5	6	7	0	
69. H. R.	F.	6- 0- 7	3rd	1	2	3	4	5	6	7	0	
70. A. B. C...	F.	6- 0-13	5th	1	2	3	4	7	5	6	0	
71. S. F.	F.	6- 0-16	1st	1	2	3	4	5	6	7	0	
72. M. L. K..	F.	6- 0-20	1st	2	1	3	4	5	6	7	0	
73. M. P.	F.	6- 0-23	2nd	1	2	3	4	5	7	6	0	
74. I. S.	F.	6- 1- 0	2nd	1	2	3	4	5	7	6	0	

Fig. XVII.—C. D., Female, 4 Years, 8 Months, 18 Days.

Fig. XVIII.—T. W., Male, 6 Years, 11 Months, 11 Days.

Fig. XIX.—E. W., Female, 3 Years, 6 Months, 21 Days.

Fig. XX.—H. W., Male, 5 Years, 2 Months, 21 Days.

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
75. M. C. R..	F.	6- 1- 4	4th	1	2	3	4	7	5	6	0	
76. N. W.	F.	6- 2-15	4th	1	2	3	4	5	6	7	0	
77. V. A.	F.	6- 3- 0	2nd	1	2	3	4	5	6	7	0	
78. J. L.	F.	6- 3- 4	7th	1	2	3	4	5	7	6	0	
79. L. P.	F.	6- 3- 7	4th	1	2	3	4	0	0	0	0	
80. C. C.	F.	6- 3- 7	1st	1	2	3	0	0	4	0	0	
81. V. M.	F.	6- 3-29	2nd	1	2	3	4	7	5	6	0	
82. N. D.	F.	6- 4- 2	1st	1	2	3	5	4	0	0	0	
83. E. S.	F.	6- 4-22	2nd	1	2	3	4	0	0	0	0	
84. E. N.	F.	6- 5-28	7th	1	2	3	4	5	6	7	0	
85. A. M.	F.	6- 6-15	1st.	1	2	3	4	6	5	7	0	
86. A. B.	F.	6- 6-20	2nd	1	2	3	4	5	6	7	0	
87. O. P.	F.	6- 7- 2	2nd	1	2	3	4	5	0	0	0	
88. E. R.	F.	6- 7- 3	4th	1	2	3	4	5	6	7	0	
89. B. S.	F.	6- 7- 7	1st	1	2	3	4	7	s	s	0	
90. B. S.	F.	6- 7- 7	2nd	1	2	3	4	7	s	s	0	
91. J. F.	F.	6- 9- 9	1st	1	2	3	4	5	6	7	0	
92. T. F.	F.	6- 7-15	2nd	1	2	3	7	5	4	6	0	
93. E. V.	F.	6- 7-17	1st	1	2	3	4	5	7	6	0	
94. M. F. C..	F.	6- 8- 8	2nd	1	2	3	4	7	5	6	0	
95. V. G.	F.	6- 8-10	6th	1	2	3	4	5	6	7	0	
96. V. L.	F.	6- 8-11	1st	1	2	3	7	6	4	5	0	
97. N. W. ...	F.	6- 8-29	...	1	2	3	4	5	6	7	0	
98. G. F.	F.	6- 9- 9	2nd	1	2	3	4	5	6	7	0	
99. I. E.	F.	6-11- 2	4th	1	2	3	4	5	7	6	0	
100. M. S.	F.	7- 0- 2	1st	1	2	3	4	7	5	6	0	
101. J. S. C...	F.	7- 1- 2	4th	1	2	3	4	5	7	6	0	
102. M. L. B...	F.	7- 2- 5	1st	1	2	3	4	5	7	6	0	
103. J. B.	F.	7- 2-20	2nd	1	2	3	4	5	6	7	0	
104. D. T.	F.	7- 4- 0	5th	1	2	3	4	5	7	6	0	
105. A. T.	F.	7- 4-21	2nd	1	2	3	4	5	6	7	0	
106. M. K.	F.	7- 4-18	3rd	1	2	3	4	5	6	7	0	
107. M. K.	F.	7- 4-18	4th	1	2	3	4	5	6	7	0	
108. M. S.	F.	7- 6- 4	5th	1	2	3	4	5	6	7	0	
109. A. C.	F.	7- 7- 0	2nd	1	2	3	4	5	6	7	0	
110. S. P.	F.	7- 7- 0	7th	1	2	3	4	6	7	5	8	P. .4
111. S. J.	F.	7- 8- 6	4th	1	2	3	4	5	6	7	0	
112. S. B.	F.	7- 9-11	4th	1	2	3	4	5	6	7	0	
113. V. H.	F.	7-10-16	1st	1	2	3	4	5	6	7	0	
114. M. B. W..	F.	8- 0- 0	4th	1	2	3	4	5	6	7	0	
115. M. A. M..	F.	8- 1- 4	2nd	..	..	..	..	..	..	..	8	P. 3
116. R. M.	F.	8- 1- 6	3rd	2	1	3	4	5	6	7	0	
117. A. M. R..	F.	8- 2-14	1st	..	..	..	..	..	..	..	0	
118. M. P.	F.	8- 3- 0	6th	..	..	..	..	..	..	..	0	
119. M. L. B..	F.	4- 4-13	2nd	..	..	..	..	..	..	..	0	
120. M. J.	F.	8- 8-18	2nd	..	..	..	..	..	..	..	8	P. 2
121. B. R.	F.	8- 9-17	3rd	1	2	3	4	5	6	7	0	
122. M. B. W..	F.	8-11-16	4th	1	2	3	4	5	6	7	0	
123. M. D.	F.	9- 0- 0	4th	..	..	..	..	..	..	..	8	P. 3
124. L. D.	F.	9- 8- 6	4th	..	..	..	..	..	..	..	8	P. 2
125. E. S.	F.	9-11-15	2nd	1	2	3	4	5	6	7	0	
126. E. R.	F.	9-11-16	5th	..	..	..	..	..	..	..	0	

Fig. XXI.—V. C., Female, 5 Years, 10 Months, 14 Days.

Fig. XXII.—E. C., Female, 5 Years, 9 Months, 14 Days.

Fig. XXIII.—I. M. F., Female, 5 Years, 1 Month, 12 Days.

Fig. XXIV.—A. P., Female, 5 Years, 6 Months, 1 Day.

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
127. L. C.	F.	10-0- 0	4th	..	..	..	..	..	..	..	8	P. 7
128. E. R.	F.	10-5-27	2nd	..	..	..	..	..	..	..	8	P. 4
129. C. N.	F.	10-5-27	...	..	..	..	..	..	..	..	8	P. 5
130. S. B.	F.	10-6-27	...	..	..	..	..	..	..	..	8	P. 4
131. L. A.	F.	10-7-26	1st	..	..	..	..	..	..	..	0	
132. A. W. ...	F.	11-2-15	...	..	..	..	..	..	..	..	8	P. 7
133. M. R. ...	F.	11-6- 4	3rd	..	..	..	..	..	..	..	8	P. 7
134. T. S. M...	F.	11-8- 6	1st	..	..	..	..	..	..	..	8	P. 8
135. L. D.	F.	12-1 9	3rd	..	..	..	..	..	..	..	8	P. 6
136. K. N.	F.	12-7- 9	3rd	..	..	..	..	..	..	..	8	P. 10
1. G. K.	M.	44	1st	0	0	0	0	0	0	0	0	
2. G. W. ...	M.	7-12	4th	1	0	0	0	0	0	0	0	M. 1.5
3. P. M.	M.	7-19	5th	0	1	0	0	0	0	0	0	U. .3
4. P. M.	M.	1- 6- 6	5th	2	1	0	0	0	0	0	0	M. 3-U. 4
5. W. S.	M.	1- 9-10	1st	1	2	3	0	0	0	0	0	M. 9-U. 7-C. 3
6. J. K. R..	M.	2- 1- 7	3rd	1	2	0	0	0	0	0	0	M. 6-U. 5
7. L. M.	M.	2- 7-19	12th	1	2	0	0	0	0	0	0	M. 9-U. 8
8. G. G.	M.	3- 0- 5	1st	1	2	0	0	0	0	0	0	M. 8-U. 6
9. T. K.	M.	3- 9-17	1st	1	2	3	0	0	0	0	0	C. 3
10. A. F.	M.	3-10-20	2nd	1	2	3	0	0	0	0	0	C. 5
11. W. C. ...	M.	4- 0- 0	3rd	1	2	3	4	0	0	0	0	C. 5-S. 2
12. J. D. O...	M.	4- 1-17	1st	1	2	0	0	0	0	0	0	M. 10-U. 8
13. J. E.	M.	4- 1-19	1st	1	2	3	0	0	0	4	0	C. 6-Tm. 1
14. A. L.	M.	4- 2-24	2nd	1	2	0	0	0	0	0	0	M. 11-U. 9
15. R. B.	M.	4- 2-28	1st	1	2	3	0	0	0	0	0	C. 5
16. C. G.	M.	4- 4- 3	2nd	1	2	3	4	5	0	6	0	C. 8-S. 7-Sc. 3-Tm. .8
17. H. C. T..	M.	4- 4-19	1st	1	2	0	3	0	0	0	0	S. 4.2
18. E. M. ...	M.	4- 5- 0	8th	1	2	3	4	0	0	0	0	S. 2
19. V. P.	M.	4- 6- 1	3rd	1	2	3	4	0	0	0	0	C. 6-S. 4
20. H. W. ...	M.	4- 7- 0	1st	1	2	3	4	0	0	5	0	C. 8-S. 7-Tm. 3
21. L. M.	M.	4- 8-10	3rd	1	2	3	4	0	0	0	0	S. 5
22. H. M. R..	M.	4- 8-28	1st	1	2	3	4	0	0	5	0	S. 3.5-Tm. 3
23. R. Q.	M.	4-10-11	4th	1	2	3	4	0	0	5	0	S. 5
24. W. B. ...	M.	4-11-23	2nd	1	2	3	4	0	0	0	0	S. 3
25. L. N.	M.	5- 0- 0	2nd	1	2	0	0	0	0	0	0	M. 12-U. 10
26. R. P.	M.	5- 1- 0	8th	1	2	3	4	0	0	0	0	C. 7-S. 6
27. W. D. ...	M.	5- 1- 4	2nd	1	2	3	0	0	0	0	0	C. 3
28. E. K.	M.	5- 1-12	2nd	1	2	3	4	0	0	0	0	S. 4.5
29. C. C.	M.	5- 2- 5	2nd	1	2	3	4	0	0	0	0	S. .7
30. G. S.	M.	5- 2- 5	4th	1	2	3	4	0	5	6	0	Td. .7-Tm. .5
31. J. C. M...	M.	5- 2- 7	3rd	1	2	3	4	0	0	0	0	S. 4
32. J. S.	M.	5- 2- 8	5th	1	2	3	4	5	6	7	0	Sc. 6-Td. 5-Tm. 4
33. E. M.	M.	5- 2-12	10th	1	2	3	4	0	0	0	0	S. 4
34. J. D.	M.	5- 2-18	2nd	1	2	3	4	0	0	0	0	S. 1
35. H. W. ...	M.	5- 2-21	1st	1	2	3	4	0	0	5	0	Td. .2
36. T. S.	M.	5- 3- 0	3rd	1	2	0	3	0	0	0	0	S. .2
37. D. S.	M.	5- 3- 3	1st	1	2	3	4	6	7	5	0	Sc. 2.5-Td. 2-Tm. 3
38. T. N.	M.	5- 3- 5	3rd	1	2	3	4	5	0	0	0	

Fig. XXV.—L. H., Male, 6 Yrs., 4 Mons., 12 Dys., right.

Fig. XXVI.—L. H., Male, 6 Yrs, 4 Mons., 12 Dys., left.

Fig. XXVII.—S. J., Female, 7 Yrs., 6 Mons., 4 Dys., right.

Fig. XXVIII.—S. J., Female, 7 Yrs., 6 Mons., 4 Dys., left.

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
39. E. W. ...	M.	5- 3-10	1st	1	2	3	4	5	7	6	0	Sc. 1-Td. .5 Tm. .6
40. E. L.	M.	5- 3-11	2nd	1	2	3	4	0	0	5	0	M. 3
41. R. M. ...	M.	5- 3-23	1st	1	2	3	0	0	0	0	0	S. 7
42. G. B. D..	M.	5- 4- 6	3rd	1	2	3	4	0	0	0	0	S. 3
43. L. F.	M.	5- 4- 9	1st	1	2	3	4	0	0	5	0	S. 4-Tm. 2
44. W. L. ...	M.	5- 4-15	1st	1	2	4	3	0	5	0	0	C. 1-S. 3-Td. .7
45. R. J.	M.	5- 4-26	4th	1	2	3	4	5	0	0	0	Sc. 2:5 .
46. J. S.	M.	5- 5- 5	1st	1	2	3	4	0	0	5	0	S. 2-Tm. 3
47. T. B.	M.	5- 5-12	1st	1	2	3	4	0	0	0	0	S. 5
48. J. R.	M.	5- 5-22	3rd	1	2	0	0	0	0	0	0	M. 10-U. 8
49. N. K.	M.	5- 6- 3	1st	1	2	4	3	0	0	0	0	S. 4
50. H. C. T..	M.	5- 6-18	3rd	1	2	4	3	0	0	0	0	C. .2-S. .7
51. R. E.	M.	5- 6-22	1st	1	2	3	4	0	5	0	0	Td. 2
52. A. V. C...	M.	5- 8- 0	1st	1	2	3	4	0	0	5	0	Tm. 4
53. J. W.	M.	5- 8-17	1st	1	2	3	4	0	0	5	0	Tm. 3
54. G. S.	M.	5- 8-20	4th	1	2	3	4	7	5	6	0	Sc. 8-Td. 3-Tm. 2
55. A. L.	M.	5- 8-25	2nd	1	2	4	3	6	5	0	0	Sc. 2.8-Td. 1
56. G. B.	M.	5- 8-29	5th	1	2	3	0	0	0	0	0	C. 7
57. J. T. S...	M.	5- 9- 6	4th	1	2	3	4	0	5	0	0	S. 7-Td. 2
58. W. D. ...	M.	5- 9-26	2nd	1	2	3	0	0	0	0	0	C. 2
59. W. W. ...	M.	5-10- 2	2nd	1	2	3	0	0	0	0	0	C. 7
60. W. M. ...	M.	5-10- 3	1st	1	2	3	4	0	0	0	0	S. 1
61. E. T. R..	M.	5-10- 3	2nd	1	2	3	5	4	0	0	0	S. .5-Sc. 2
62. H. C. T..	M.	5-10-20	1st	1	2	4	3	0	0	0	0	S. 6
63. B. D.	M.	5-11-19	2nd	1	2	3	0	0	0	0	0	C. 3
64. L. S.	M.	6- 0- 2	2nd	1	2	3	5	0	0	4	0	S. 1-Tm. 4
65. E. M.	M.	6- 0- 4	1st	1	2	3	4	6	5	7	0	Sc. 6-Td. 7-Tm. 5
66. J. D.	M.	6- 0- 9	2nd	1	2	3	4	0	0	0	0	S. 2
67. R. G. S...	M.	6- 0-25	1st	1	2	3	4	0	0	5	0	Tm. 3.5
68. G. B. D..	M.	6- 1- 0	3rd	1	2	3	4	5	6	0	0	Sc. 3-Td. .8
69. G. M.	M.	6- 1- 0	4th	1	2	3	4	5	0	0	0	Sc. 1.5
70. J. W.	M.	6- 1- 2	7th	1	2	3	4	5	0	0	0	Sc. 4
71. R. P.	M.	6- 1-11	8th	1	2	3	4	0	0	5	0	Tm. 2.5
72. C. B.	M.	6- 1-14	2nd	1	2	3	4	0	0	0	0	S. 2.5
73. S. H.	M.	6- 1-20	4th	1	2	3	4	5	6	7	0	Sc. 9-Td. 1-Tm. 6.5
74. S. P.	M.	6- 1-28	3rd	1	2	3	4	5	0	6	0	Sc. 3-Tm. 2
75. J. T.	M.	6- 2-11	1st	1	2	3	4	0	0	0	0	S. 7
76. O. S.	M.	6- 2- 1	1st	1	2	3	4	0	0	5	0	Tm. .8
77. E. B.	M.	6- 2- 6	1st	1	2	3	4	0	0	0	0	S. 6
78. F. V.	M.	6- 2-16	8th	1	2	3	4	0	0	0	0	S. 7
79. T. N.	M.	6- 2-21	3rd	1	2	3	4	5	6	0	0	Sc. 6-Td. 4
80. L. S.	M.	6- 2-22	1st	1	2	3	4	0	0	0	0	S. 2
81. E. W.	M.	6- 2-26	1st	1	2	3	4	5	6	7	0	Td. 7-Tm. 6
82. H. W. ...	M.	6- 2-28	3rd	1	2	3	4	0	5	0	0	Td. 1.5
83. A. L.	M.	6- 3- 0	3rd	1	2	4	3	6	5	0	0	Sc. 4-Td. 5
84. J. P.	M.	6- 3- 0	1st	1	2	3	6	0	4	5	0	Td. 4-Tm. 2
85 .C. W. ...	M.	6- 3- 5	3rd	1	2	3	4	5	6	0	0	Sc. 6-Td. 4.5
86. L. M.	M.	6- 3-23	6th	1	2	3	4	0	0	0	0	S. 5

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
87. M. H. ...	M.	6- 4-17	...	1	2	3	4	5	6	7	0	
88. L. H.	M.	6- 4-19	3rd	1	2	3	4	0	0	0	0	
89. J. K.	M.	6- 4-23	5th	1	2	3	4	5	7	6	0	Td. 1-Tm. 2
90. H. W. ...	M.	6- 5- 0	3rd	1	2	3	4	0	5	0	0	Td. 2.5
91. M. H. ...	M.	6- 5- 5	1st	1	2	3	4	5	6	7	0	
92. J. D.	M.	6- 5-11	5th	1	2	3	4	0	0	0	0	S. 5
93. S. T.	M.	6- 5-25	2nd	1	2	3	4	5	6	7	0	
94. G. B.	M.	6- 5-27	1st	1	2	3	4	0	0	0	0	S. 5
95. H. F.	M.	6- 6- 4	1s	1	2	..	3	0	0	0	0	S. 5
96. L. I.	M.	6- 6-12	...	1	2	3	4	0	0	0	0	S. 7
97. W. M. ...	M.	6- 6-16	7th	1	2	3	4	0	0	0	0	
98. J. D.	M.	6- 6-16	2nd	1	2	3	4	6	5	0	0	Td. 2
99. T. M.	M.	61 7- 3	2nd	1	2	3	4	0	5	6	0	Td. 3-Tm. .5
100. N. C.	M.	6- 8-11	2nd	1	2	3	4	0	0	0	0	
101. G. S.	M.	6- 9- 6	4th	1	2	3	4	5	0	0	0	
102. J. S.	M.	6- 9- 9	1st	1	2	3	4	5	..	..	0	
103. J. B. D...	M.	6-10- 9	2nd	1	2	3	4	5	0	0	0	
104. W. L.	M.	6-10-16	1st	1	2	4	3	6	5	7	0	
105. T. W. ...	M.	6-11-16	5th	1	2	3	4	6	5	0	0	Sc. 1
106. R. P.	M.	7- 0- 0	8th	1	2	3	4	6	7	5	0	
107. G. M.	M.	7- 1- 4	1st	1	2	3	4	0	0	0	0	
108. M. M. ...	M.	7- 1-26	2nd	1	2	3	4	5	7	6	0	
109. W. K. ...	M.	7- 2-27	4th	1	2	3	4	5	0	0	0	
110. W. M. ...	M.	7- 3-25	9th	1	2	3	4	6	0	5	0	
111. J. V.	M.	7- 4- 9	3rd	1	2	3	4	7	6	5	0	
112. G. L.	M.	7- 7- 0	2nd	1	2	3	4	5	6	7	0	
113. A. C.	M.	7- 7- 4	3rd	1	2	3	4	..	..	..	0	
114. D. G.	M.	7- 8-10	6th	1	2	3	4	5	6	7	0	
115. F. D.	M.	7- 9-13	2nd	1	2	3	4	5	6	7	0	
116. C. L.	M.	7- 9-22	6th	1	2	3	5	6	4	7	0	
117. G. M.	M.	8- 0- 1	4th	2	1	3	4	5	6	7	0	
118. T. M.	M.	8- 1- 4	2nd	1	2	3	4	7	5	6	0	
119. R. M.	M.	8- 2-25	8th	1	2	3	4	0	6	5	0	
120. D. B.	M.	8- 3-23	3rd	1	2	3	4	0	0	0	0	
121. E. M.	M.	8- 6- 4	2nd	1	2	3	4	6	7	5	0	
122. L. P.	M.	8- 7-21	9th	1	2	3	4	5	6	7	0	
123. W. D. ...	M.	8- 8- 2	3rd	1	2	3	4	5	6	7	0	
124. A. M.	M.	8- 9-26	1st	..	..	..	..	..	..	..	0	
125. M. S.	M.	8-10-13	...	1	2	3	4	6	5	0	0	
126. R. B. G...	M.	9- 4- 8	5th	..	..	..	..	..	..	..	0	
127. R. R.	M.	9- 5- 2	7th	..	..	..	..	..	..	..	0	
128. V. S.	M.	9- 7-16	3rd	1	2	3	4	5	7	6	0	
129. L. F.	M.	9- 8- 7	3rd	1	2	3	4	5	6	7	0	
130. L. B. M..	M.	9- 9-14	7th	1	2	3	4	7	6	5	0	
131. P. C.	M.	9-10- 8	2nd	..	..	..	..	..	..	..	0	
132. C. R.	M.	9-11- 4	4th	..	..	..	..	..	..	..	0	
133. J. M.	M.	9-11-26	1st	1	2	3	4	5	6	7	0	
134. E. E.	M.	10- 4-13	1st	..	..	..	..	..	..	..	0	
135. W. S.	M.	10- 5-13	4th	1	2	3	4	5	6	7	0	
136. H. F.	M.	10- 5-16	3rd	..	..	..	..	..	..	..	0	
137. W. E. ...	M.	10- 7-10	4th	..	..	..	..	..	..	..	0	

CHRONOLOGICAL TABLE, (Continued).

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.	Size of Nucleus in M. M.
138. S. F.	M.	10- 8- 0	3rd	..	..	..	..	..	..	..	0	
139. W. T. ...	M.	10- 9- 0	1st	..	..	3	4	5	6	7	0	
140. B. B.	M.	11- 0- 4	6th	..	..	..	..	..	..	..	0	
141. W. T. ...	M.	11- 3- 3	...	1	2	3	4	6	5	7	0	
142. F. R.	M.	11- 3-23	6th	..	..	..	..	..	..	..	0	
143. B. T.	M.	11- 4-22	3rd	..	..	..	..	..	..	..	0	
144. H. F.	M.	11- 8- 0	1st	..	..	..	..	..	..	..	8	P. 2
145. C. W.	M.	12- 6- 0	4th	..	..	..	..	..	..	..	0	
146. W. C.	M.	12- 6-24	1st	..	..	..	..	..	..	..	0	
147. R. F.	M.	12- 9- 4	2nd	..	..	..	..	..	..	..	8	P. 10
148. D. V.	M.	12-10- 0	...	..	..	..	..	..	..	..	8	P. 5
149. E. M.	M.	12-10-21	1st	..	..	..	..	..	..	..	0	
150. R. W. ...	M.	13- 0- 6	4th	..	..	..	..	..	..	..	0	
151. E. P.	M.	13- 7-25	6th	..	..	..	..	..	..	..	8	P. 8
152. E. S.	M.	13- 9- 5	1st	..	..	..	..	..	..	..	8	P. 6
153. J. F.	M.	14- 0-16	4th	..	..	..	..	..	..	..	0	

The os magnum is the first bone in the human carpus to begin the process of ossification. In the hand of the female, the first point will make its appearance before the child is six months of age. In exceptional instances ossification may begin before birth. This I believe to be the case with No. 2—E. C., age six month. In this hand the nucleus of the magnum is five m. m. in diameter and that of the unciform is three m. m. The former must have made its appearance before birth, and that of the latter soon after birth. Then in the hand of No. 3—P. D. D., age eight months and five days—the magnum is five m. m. in diameter. The youngest of the female hands of which I have made a negative is that of No. 1—A. C. K., age three months and eight days. This negative shows a pin point of ossification in the unciform.

Another exposure of this hand at the age of one year, five months and one day shows the nucleus of the unciform is five m. m., and that of the magnum is four m. m. in diameter. In all of the hands of those under three years of age, the size of the nucleus would indicate the average appearance of the magnum between the third and sixth month, and that of the unciform a few months later.

The cuneiform will make its appearance between the second and third years. The fourth bone of the carpus to begin ossification is the semilunar, the nucleus of which will appear between the third and fourth year; while that of the scaphoid will appear when the child is about four years of age, or early in the fifth year. It is only in rare or exceptional instances that you find the semilunar or scaphoid appearing after the child is five years of age.

The trapezoid and trapezium will make their appearance between the fourth

and fifth year, in the order named. The last bone, or pisiform, will begin ossification between the ninth and tenth year. An examination of the table will show that in only six instances can we record the absence of any of the bones that should be present when the child was six years of age or older. The oldest hand of the female showing the absence of the trapezoid and trapezium is that of No. 87—O. P., age six years, seven months and two days.

The male hand is slower to develop. The difference is measured at first by days, then months, then years. An examination of this part of the table will show that in only six instances can we find the absence of any of the seven bones of the carpus that should be present when the child was seven years of age or older.

The oldest of the male hands showing the absence of any of these bones is that of No. 125—M. S., age eight years, ten months and thirteen days. In this hand the trapezium has not made its appearance. The slowest of the male hands in developing is that of No. 120—D. B., age eight years, three months and twenty-three days. In this hand the scaphoid, trapezoid, and the trapezium have not appeared.

The chronological order in which the bones of the human carpus are ossified is as follows: 1, Os Magnum. 2, Unciform. 3, Cuneiform. 4, Semilunar. 5, Scaphoid. 6, Trapezoid. 7, Trapezium. 8, Pisiform.

In the summary of the table we find that in two hundred and forty-three (243) hands there is good evidence that the magnum appeared first two hundred and thirty-eight (238) times and the unciform five (5) times. In two hundred and forty-one (241) hands the unciform appeared first in five (5) instances and the magnum two hundred and thirty-six (236) times.

In those hands in which the cuneiform had made its appearance it came in the third place two hundred and nineteen (219) times, and in the fourth place ten (10) times. You will observe that the cuneiform is not displaced by any of the other bones except the semilunar, which appeared in the third place twelve (12) times, and in its own position, the fourth, one hundred and seventy-six (176) times. Eight (8) times in the fifth position, twice (2) in the sixth, and six (6) times in the seventh place, in a total of two hundred and four (204) instances.

In one hundred and twenty-nine (129) hands we find the scaphoid has appeared. Of this number it appeared three (3) times in the fourth position, eighty (80) times in the fifth, twenty-seven (27) times in the sixth, and nineteen (19) times in the seventh place.

The table shows one hundred and twenty-four (124) hands in which the trapezoid presents a point of ossification or a very large nucleus. In eight (8) instances it appeared in the fourth place, thirty-six (36) times in the fifth, fifty-nine (59) times in the sixth, and twenty-one (21) times in the seventh position.

The trapezium made its appearance seven (7) times in the fourth position,

thirty (30) times in the fifth, thirty-one (31) times in the sixth, and fifty-one (51) times in its own position, that of the seventh.

There are nineteen (19) showing a nucleus of ossification in the pisiform, all appearing in the eighth position. This may be more distinctly seen in the form of a summary.

SUMMARY.

	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.
First	238	5	....	....	....	....	....	....
Second	5	236	....	....	....	....	....	....
Third	...	....	219	12	....	....	....	....
Fourth	...	....	10	176	3	8	7	....
Fifth	...	....	....	8	80	36	30	....
Sixth	...	....	....	2	27	59	31	....
Seventh	...	....	....	6	19	21	51	....
Eighth	...	....	....	....	....	....	....	19
Total.....	243	241	229	204	129	124	119	19

If my conclusions are correct in placing them in the order in which they are found in the table, and, as I have said, I have used only those in which the order was distinct; there can hardly be a question that the chronological order of ossification is in accordance with this table. It will, however, be seen there are all kinds of variations, or what might be called combinations; thus, the magnum or unciform may be found in either the first or second positions, but they are never displaced by any of the other bones.

The cuneiform is rarely displaced from the third position, and then only by the semilunar. The latter bone has a strong hold on the fourth place, but it may be found in the third, fifth, sixth or seventh positions; that is, in exceptional instances.

The scaphoid, trapezoid, and the trapezium frequently exchange positions.

Fig. I represents the order in which the average will occur, viz.: 1. *os magnum.* 2, *unciform.* 3, *cuneiform.* 4, *semilunar.* 5, *scaphoid.* 6, *trapezoid.* 7, *trapezium.* 8, *pisiform.*

In Fig. II, we have an instance in which the unciform is found in the first position, preceding the magnum. Fig. III is the same hand taken eleven months later. The magnum evidently appeared soon after that of the unciform, but has not had sufficient time for its nucleus to grow larger than the last named bone. In Fig. IV the cuneiform is in its proper position, that is the third. In Figs. V and VI, the semilunar has appeared in the third position in advance of the cuneiform. Fig. VII shows the scaphoid has preceded the semilunar and is found in

the fourth position; and in Fig. VIII the trapezoid is in the fourth place, trapezium fifth, scaphoid sixth, and the semilunar seventh. Figs. IX and X are the right and left hands, in which we find the trapezoid in the fourth position and the scaphoid fifth. There is quite a large nucleus of all of these bones. The semilunar has not made its appearance. In Figs. XI and XII the trapezium has appeared in the fourth position, the scaphoid fifth, the semilunar sixth, and the trapezoid seventh, in the right and left hands. In Figs. XIII and XIV the trapezium is in the fifth position. We have still another arrangement in Fig. XV, in which we see the trapezoid fourth, the trapezium fifth, and the semilunar sixth. Fig. XVI is somewhat different; the trapezoid is in the fourth place and the semilunar fifth. In Figs. XVII and XVIII the trapezoid is fifth and the scaphoid sixth. In the hands of a brother and sister, Figs. XIX and XX, we find the trapezium in the fifth position. Figs. XVI and XVII show the trapezoid in the fifth position, the trapezium sixth, and the scaphoid seventh; and in Figs. XXIII and XXIV the trapezium is in the fifth and the trapezoid is in the sixth positions.

This may be more graphically shown when grouped and in tabular form, as follows:

Name.	Sex.	Age.	Child.	Magnum.	Unciform.	Cuneiform.	Semilunar.	Scaphoid.	Trapezoid.	Trapezium.	Pisiform.
1. N. V.	F.	6- 2-15	4th	1	2	3	4	5	6	7	0
2. P. M	M.	7-19	5th	0	1	0	0	0	0	0	0
3. P. M.	M.	1- 6- 6	5th	2	1	0	0	0	0	0	0
4. W. S.	M.	1- 0- 0	1st	1	2	3	0	0	0	0	0
5. H. C. T....	M.	6- 4-25	5th	1	2	4	3	0	0	0	0
6. L. F.	F.	5- 9-28	1st	1	2	4	3	6	5	0	0
7. E. T. R.....	M.	5-10- 3	2nd	1	2	3	5	4	0	0	0
8. M. R.	F.	5- 1- 9	1st	1	2	3	7	6	4	5	0
9. C. B.	F.	5- 9-11	3rd	1	2	3	0	5	4	0	0
10. C. B.	F.	5- 9-17	3rd	1	2	3	0	5	4	0	0
11. S. G.	F.	5- 0- 1	2nd	1	2	3	7	5	6	4	0
12. S. G.	F.	5- 0- 1	2nd	1	2	3	7	5	6	4	0
13. L. F.	M.	5- 4- 9	1st	1	2	3	4	0	0	5	0
14. L. F.	M.	5- 4- 9	1st	1	2	3	4	0	0	5	0
15. J. P.	M.	6- 3- 0	1st	1	2	3	6	0	4	5	0
16. J. B.	F.	6- 0- 0	1st	1	2	3	5	0	4	0	0
17. B. D.	F.	4- 8-18	5th	1	2	3	4	6	5	0	0
18. T. W.	M.	6-11-16	5th	1	2	3	4	6	5	0	0
19. E. W.	F.	3- 6-21	2nd	1	2	3	4	6	0	5	0
20. H. W.	M.	5- 2-21	1st	1	2	3	4	0	0	5	0
21. V. C.	F.	5-10-14	2nd	1	2	3	4	7	5	6	0
22. E. C.	F.	5- 9-14	2nd	1	2	3	4	7	5	6	0
23. I. M. F.....	F.	5- 1-12	6th	1	2	3	4	0	6	5	0
24. A. P.	F.	5- 6- 1	4th	1	2	3	4	7	6	5	0

In extremely rare instances some of the bones of the carpus are developed from two nuclei.

In Figs. XXV and XXVI we have the right and left hand showing a double nucleus in the cuneiform and semilunar. The position of the tube will account for the difference in the shadow in the two hands. The negatives show the two nuclei in each bone distinctly.

In Figs. XXVII and XXVIII there is a double nucleus in the trapezoid of the right hand, but it is not found in the left hand, as will be seen.

These are the only instances in which I have observed two points of ossification in a single bone.

Other observers have recorded the presence of the *os centrale,* the *os subcapitalum,* and the *styloid* process of the *third metacarpal* bone as separate and distinct bones. I have not been able to find indications of any of these variations in my negatives.

In arriving at these conclusions, a number of factors are to be taken into consideration. The rate of growth varies in different families. In some families the bones ossify with much greater rapidity than others. Condition of health, accidents, disease, anything that would interfere with the blood supply or modify metabolism, would be likely to delay or modify the process of ossification.

The shadow of the nucleus is somewhat larger than the object, and the conditions under which the exposures are made should be uniform, such as the distance of the tube from the plate, the time of exposure and the development of the plate. should all be considered. Making all possible allowance for errors on account of these factors, and using such cases in which I have obtained negatives showing minute points of ossification; then making subsequent exposures of these hands at frequent intervals, one, two or more months apart, I have been able to approximate the rate of growth. Then taking the size of the nucleus in m. m., we can estimate the times of appearance with as much freedom from error as could be determined by other methods.

In the frontispiece we have an instance in which the trapezium in the male hand has made its appearance at a very late date.

CONCLUSIONS.

CARPUS.

1. Os Magnum.
   - *Female:* between the third and sixth month.
   - *Male:* between the fourth and tenth month.
2. Unciform...
   - *Female:* between the fifth and tenth month.
   - *Male:* between the sixth and twelfth month.
3. Cuneiform..
   - *Female:* between the second and third year.
   - *Male:* when about three years of age.
4. Semilunar..
   - *Female:* between the third and fourth year.
   - *Male:* when about four years of age.
5. Scaphoid....
   - *Female:* at four years of age, or early in fifth year.
   - *Male:* when about five years of age.
6. Trapezoid...
   - *Female:* between fourth and fifth year (preceding trapezium).
   - *Male:* between fifth and sixth year (preceding trapezium).
7. Trapezium..
   - *Female:* between fourth and fith year (preceded by trapezoid).
   - *Male:* between fifth and sixth year (preceded by trapezoid).
8. Pisiform....
   - *Female:* between the ninth and tenth year.
   - *Male:* between the twelfth and thirteenth year.

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